Running head: USING LOW-BANDWIDTH VIDEO IN TELEPSYCHOLOGY

Cost Effectiveness of Using Low-Bandwidth Video-teleconferencing in the Neuropsychology Service at Naval Medical Center San Diego

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An increasing number of health care specialties are now using telemedicine to deliver healthcare. This paper reviewed the use of low-bandwidth equipment (LBE) in the Neuropsychology Service at Naval Medical Center San Diego and revealed that use of LBE for assessment was cost-effective. The use of LBE not only decreased cost, but also increased access while maintaining the quality of healthcare delivered. Cost was decreased as the neuropsychologist interviewed patients with the LBE, avoiding unnecessary TAD/TDY costs. Using the relatively inexpensive LBE which did not need costly communication lines or expensive hardware also decreased costs. Access to neuropsychology services increased because unnecessary trips to San Diego were avoided.

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ABSTRACT

An increasing number of health care specialties are now using telemedicine to deliver healthcare. This paper reviewed the use of low-bandwidth equipment (LBE) in the Neuropsychology Service at Naval Medical Center San Diego and revealed that it was cost-effective to use for neuropsychological assessment. The use of LBE not only decreased cost, but also increased access while maintaining the quality of healthcare delivered. Cost was decreased as the neuropsychologist interviewed patients with the LBE, avoiding unnecessary TAD/TDY costs. Using the relatively inexpensive LBE which did not need costly communication lines or expensive hardware also decreased costs. Access to neuropsychology services increased because unnecessary trips to San Diego were avoided.

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Conditions which Prompted the Study

Maintaining a combat ready force is of prime importance to the Military Healthcare System (MHS). This means keeping the fighting forces fit both physically and mentally. Unfortunate constraints such as a decreasing budget and downsizing of the military make maintaining readiness a formidable challenge. As the MHS functions in a managed care environment, the "Iron Triad" of healthcare -- cost, quality, and access -- becomes of prime importance. As we concentrate on decreasing costs, we must also focus on maintaining if not increasing both the quality of and access to healthcare.

TRICARE Region Nine is responsible for coordinating healthcare for military personnel (Army, Navy, Air Force, and Marine Corps) in the southern California area. Table 1 reflects the military medical facilities represented in the region along with the total eligible beneficiaries served by each facility.

Table 1

Military Medical Facilities in Region Nine and Total Eligible Beneficiaries

Medical Facility	Total Eligible Beneficiaries
Vandenberg Air Force Base	18,595
Edwards Air Force Base	20,174
Los Angeles Air Force Base	18,174
Fort Irwin	14,966
Naval Hospital Twenty-nine Palms	23,860
Naval Hospital Camp Pendleton	177,531
Yuma Marine Corps Air Station and Yuma Army Proving Grounds	13,373
Naval Medical Center San Diego	257,658
Total	643,848

Note. From the Health Affairs Enrollment Report dated 3 March 1998.

As mentioned before, resources are scarce in the MHS, and TRICARE Region Nine is no exception. The largest Military Treatment Facility (MTF) in the region is Naval Medical Center San Diego (NMCSD). It is the Navy's largest MTF and is responsible for much of the Navy's medical training through its Graduate Medical Education and other

training programs. Most of the medical specialists who provide services for the TRICARE Region Nine area are stationed at NMCSD. Therefore NMCSD receives requests for consultation by these specialty providers from the various smaller MTFs located throughout southern California. The demand for these specialty services is great while the resources remain scarce.

One example of scarce resources is the one neurobehavioral psychologist (neuropsychologist) at NMCSD who must handle all of the consultation requests for TRICARE Region Nine.

When patients in Region Nine are referred to neuropsychology, they must travel to NMCSD to be evaluated. A patient is initially seen by a neuropsychology technician and is then assessed and tested by the neuropsychologist. This involves a battery of tests which usually takes about six hours which does not take include the travel time involved. Patients are referred from all the different military treatment sites in southern California, including the 30th Medical Group at Vandenberg Air Force Base, the 95th Medical Group at Edwards Air Force Base, the 61st Medical Squadron at Los Angeles Air Force Base, Weed Army Community Hospital at Fort Irwin, Naval Hospital Twenty-nine Palms, Naval Hospital Camp Pendleton, the military medical clinics in Yuma Arizona (Marine Corps Air Station and Yuma Army

Proving Grounds) and Naval Medical Center San Diego (serving all the bases and branch clinics in the greater San Diego area). Table 2 shows the round-trip mileage from the various sites to NMCSD.

Table 2

Round Trip Mileage from Remote Sites to Naval Medical Center San Diego

Remote Site (in miles)	Round Trip Mileage
Los Angeles Air Force Base	242
Vandenberg Air Force Base	580
Edwards Air Force Base	402
Fort Irwin	436
Twenty-Nine Palms Naval Hospital	348
Camp Pendleton Naval Hospital	78
Yuma Army Proving Ground	220

One prerequisite for testing is that the patient be well-rested. Because of long distances and the requirement for a well-rested patient, it is necessary for most (if not all) patients to travel to San Diego the day before the appointment and spend the night. Appointments are usually scheduled to begin in the morning, so out of town patients

are usually able to drive back to their duty stations once the testing is completed.

Every patient given a consultation request to see the neuropsychologist must travel to NMCSD, so no preliminary screening is done by any of the NMCSD staff before the patient arrives in San Diego. Because the referring physicians are not usually experts in neurobehavioral psychology, some patients are inappropriately referred for evaluation. As such, these patients are required to make an unnecessary trip.

Statement of the Problem

Invaluable man hours are lost and TAD/TDY money spent in sending to San Diego every patient who is thought to require neuropsychology referral but for whom preliminary screening or triage to assess the appropriateness of the referral is not available. By the time the specialist has determined that a given consultation request is unnecessary, the patient has already made the trip and incurred the lost man hours in travel along with the cost of lodging and meals. Limited resources require that we find innovative ways of delivering this service to patients while trying to reduce costs, maintain quality, and increase access. Reducing the amount of unnecessary referrals would result in savings of both lost man hours and TAD/TDY costs.

Literature Review

Providing healthcare for a large geographic region using limited resources is not a problem unique to the MHS. Providing healthcare to rural areas of the United States has been a challenge for many years (Allen, Cox, & Thomas, 1992). To meet the challenge, medicine has tried to extend its arms to encompass rural areas through the use of telemedicine. Many examples of the use of telemedicine have been documented in the literature.

Telemedicine can be defined as the use of telecommunications technology to provide medical information and services (Perednia, 1995). The literature documents a variety of dates for the genesis of telemedicine. Most sources point to the 1950s and 60s as being the decades in which telemedicine began. However, very early examples include the use of bonfires to pass on information concerning bubonic plague, famine, and war across Europe in medieval times. During the Civil War the telegraph was an important tool used to transmit health care information such as numbers of casualties and outbreaks of disease. The telephone has been used for over 50 years as a conduit for passing on health information and is the form of telemedicine which has been in use the longest (Zundel, 1996).

The advent of telemedicine as we think of it today -- using monitors to visualize patients and collect data from a distance -- stems from research conducted by the National Aeronautics and Space Administration in its manned space-flight program. During the 1960s and early 1970s, the federal government funded several telemedicine research-and-demonstration projects. Many of these were aimed at delivering medicine throughout rural areas of the United States. Examples include INTERACT, based at Dartmouth Medical School in Hanover, New Hampshire; Rural Health Associates in Farmington, Maine; the Puerto Rico telemedicine program in Ponce, Puerto Rico; Lakeview Clinic in Waconia, Minnesota; Alaska Native Program in Alaska and Seattle, Washington; and the Space Technology Applied to Rural Papago Advanced Health Care (STARPAHC) project on the Papago reservation in southern Arizona. These projects demonstrated that it was possible to use telecommunications to deliver medicine where access to medical care was a challenge (Zundel, 1996).

Goldberg (1996) attributes renewed interest in telemedicine to rapid advances in technology in the areas of information management and telecommunications. He also states that the renewed interest is due to the changing world of healthcare in the United States which demands

"equal access to high quality medical care at affordable cost" (1996, p. 648).

Telemedicine has been used with great success in various areas of medicine including radiology, anesthesia, dermatology, cardiology, psychiatry, critical care, and oncology. It has also been used in delivering patient education, home monitoring, and continuing medical education (Zundel, 1996). Teleradiology (the use of telemedicine in radiology) is the most mature of the subspecialties. Radiology uses the technology to store images within departments in order to save space and for convenience. It also uses telemedicine to transmit images to distant locations for primary readings or second opinions. This function can be accomplished in real time (so the radiologist can read the films as soon as the image is received) or in the "store-and-forward" function in which the image is sent, stored and read by the radiologist at a later, more convenient time (Goldberg, 1996).

Anesthesia has used telemedicine to supervise and direct non-physician providers in remote areas in the administration of anesthesia. Dermatology has been able to expand its specialty through the use of dermascopes to transmit images to specialists for evaluation. Before the use of this technology patients would have to travel to the specialists in order to be evaluated. Cardiology has also

made great strides in the world of telemedicine by conducting real time interpretation and diagnosis of dysrhythmias. In a few cases, fatal dysrhythmias have also been treated by defibrillation through telemedicine connections. Psychiatry has used telemedicine by providing day-to-day professional consultation and support. Critical care has used telemedicine to provide the expertise of an intensive care specialist to small hospitals which lack this medical specialty. Likewise, oncologists have been able to effectively provide oncology consultation to remote locations (Zundel, 1996).

Telemedicine has also been applied to areas other than the delivery of specialty medicine. Other applications of telemedicine are documented in the area of patient education. Health information is at the patient's fingertips through a myriad of sites on the internet. Not only can patients get information, but caregivers can also obtain information and support from other caregivers of persons with acute or chronic illnesses. Telemedicine is also being used as a triage tool to determine whether a patient needs only self-care instructions or if they need to go to an emergency room. As the practice of medicine has changed through the years, it is no longer cost-effective to keep a patient in an acute care hospital setting when the patient does not need it. Rather, patients are discharged

earlier, thereby decreasing their length of stay in the hospital. Through telemedicine, physicians may monitor patients who are recuperating in the comfort of their home. The healthcare provider can be alerted when a patient's vital signs fall out of parameters or when a demented patient wanders outside. Telemedicine has also allowed physicians to keep abreast of groundbreaking procedures and the latest information and equipment. Physicians may also earn necessary Continuing Medical Education credit by viewing tapes or through interactive television, allowing them to ask questions of the presenter (McGee & Tangalos, 1994).

Psychiatry has successfully used telemedicine to provide mental health care to underserved geographical areas. A few studies have been published concerning the use of telemedicine for assessment or treatment of psychiatric disorders. In many cases, patients actually prefer video interviews over live interviews. A study was conducted which successfully used both higher and lower bandwidth to assess schizophrenic patients in remote locations. The study looked at whether video assessments were comparable to live interviews. It also looked at the differences between the use of lower bandwidth (128 kilobits per second) and higher bandwidth (384 kilobits per second) in the assessment of schizophrenic patients. The study concluded that, in

general, video interviews were just as reliable as in-person interviews. The study also concluded that for certain symptoms in which fine movement needed to be assessed, using the lower bandwidth caused shadowy effects and was less desirable than the higher bandwidth (Zarate, Weinstock, Cukor, Morabito, Leahy, Burns, & Baer, 1997). However the study also pointed out that lower bandwidth had the advantages of "lower transmissions costs, reduced equipment size, simplicity of operation, and easy interface with computers" (Zarate et al., 1997, p. 24).

Another study looked at the use of telemedicine for interviewing patients with obsessive-compulsive disorders. This study used narrow-bandwidth video transmission over a digital telephone line. It concluded that using video transmission assessments were just as reliable as live interviews (Baer, Cukor, Jenike, Leahy, O'Laughlen, & Coyle, 1995).

Purpose Variables and Working Hypothesis

The purpose of this study is to determine the cost effectiveness of using low-bandwidth video teleconferencing for patients in Region Nine who received a consultation request to see a neuropsychologist. This study will compare TAD/TDY costs associated with Fiscal Year (FY) 97 consultations with TAD/TDY costs associated with consultations for FY 98, after implementation of low-

bandwidth videoteleconferencing. The working hypothesis for this project is as follows:

H_o: It is not cost-effective to implement low-bandwidth videoteleconferencing to assess patients needing neurobehavioral psychology consults.

H_a: It is cost-effective to implement low-bandwidth videoteleconferencing to assess patients needing neurobehavioral psychology consults.

Methods and Procedures

The participants in the study used a "plain old telephone system" (POTS) line with low-bandwidth equipment. The system used an ordinary television and therefore did not require a special monitor, computer, or designated computer lines. Because of the simplicity of the system, a special knowledge of computers or extensive training was not needed prior to the start of the study. Using high tech equipment in healthcare has historically been a cause for increased cost (Bashshur, 1995). Therefore the challenge lies in finding the most appropriate technology to apply in a specific healthcare situation as opposed to the most expensive system available. High costs will more than likely prohibit the use of telemedicine in many areas of medicine (McGee & Tangalos, 1994).

Even though individuals did not need to be highly skilled computer specialists to operate the low-bandwidth

equipment, all project participants were required to attend a telemedicine implementation course. This course was a comprehensive, two-day training for medical and technical professionals designed to familiarize them with telemedicine and its implementation and application to managed care. Topics included the history of telemedicine, the use of telemedicine in the Department of Defense, legal considerations of telemedicine, security and confidentiality considerations, utilization management and demand management strategies of telemedicine and basic technical terms and applications related to telemedicine.

The course also provided an outstanding opportunity for the participants to gain actual hands-on training with the low-bandwidth equipment. During this training, participants were taught how to prepare the patient physically and emotionally for the interview. Participants were also taught how to set up the equipment in order to ensure an optimal interview environment.

Attendance at this course was necessary to ensure the smooth implementation of the telemedicine project. This prerequisite gave all the project participants a baseline understanding of the capabilities and applications of telemedicine.

Table 3 shows the equipment cost for the project. Each site was provided a video unit along with a headset. The

central site (NMCSD) was provided three video units along with three 19" television sets.

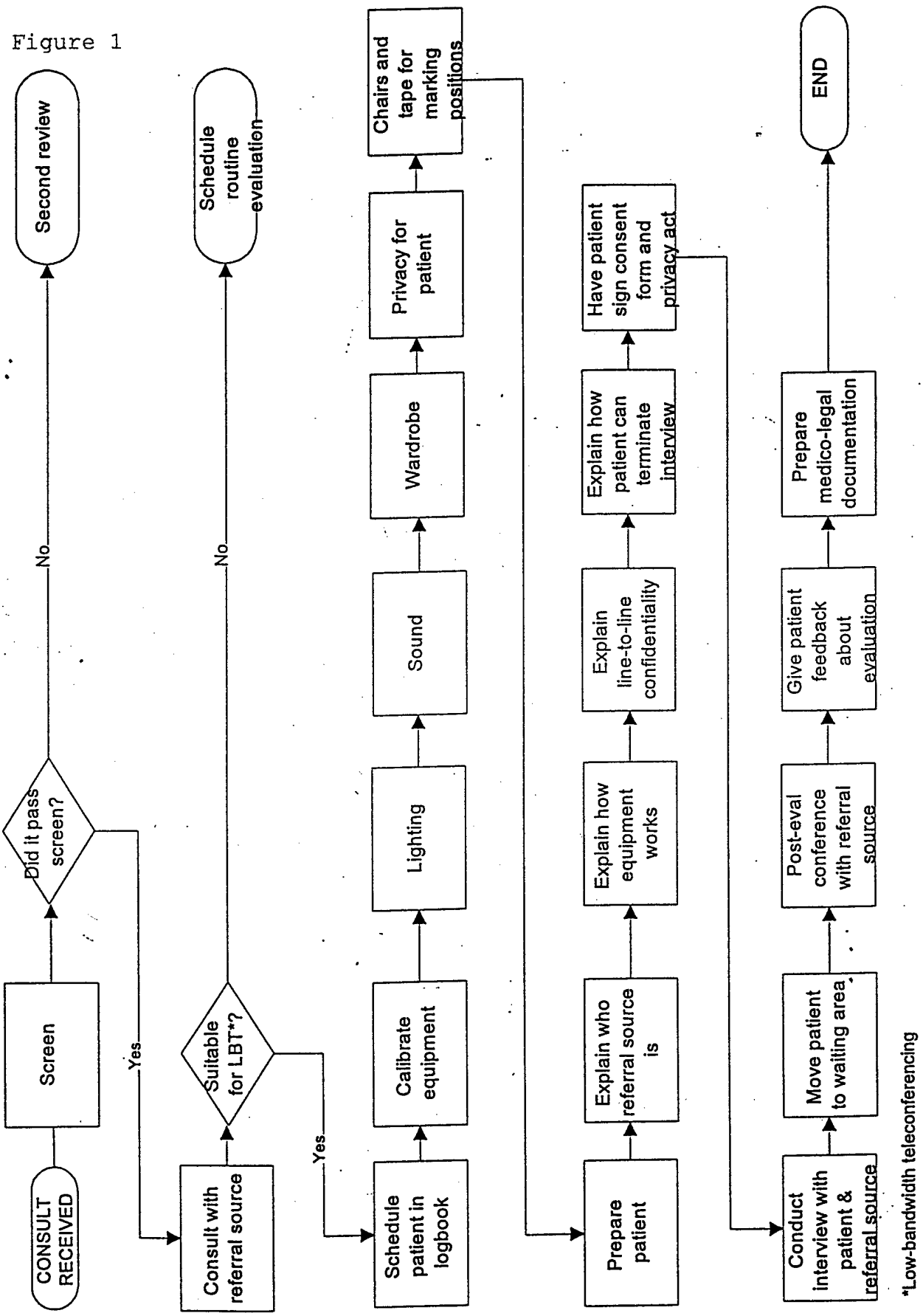
Table 3

Price and Quantity of Equipment Needed for Project

Equipment cost	Quantity	Price	Total
Video unit	11	$500	$5500
Head set	11	$100	$1100
19" TV set	3	$200	$600
Total cost			$7200

The process was kept as simple as possible. Figure 1 describes the process followed by the psychology department for each consultation request they received. Using this flowchart to track all the consultations was very important in maintaining continuity and ensuring that all of the patients were appropriately interviewed. It also ensured that all the necessary preparations were made prior to the patient's interview with the neuropsychologist. This flowchart not only assisted in a smoothly conducted interview, but also ensured that quality patient care was delivered. Because the flowchart included all of the

Figure 1


CONSULT RECEIVED
Screen
Did it pass screen?
No
Second review
Yes
Consult with referral source
Suitable for LBT*?
No
Schedule routine evaluation
Yes
Schedule patient in logbook
Calibrate equipment
Lighting
Sound
Wardrobe
Privacy for patient
Chairs and tape for marking positions
Prepare patient
Explain who referral source is
Explain how equipment works
Explain line-to-line confidentiality
Explain how patient can terminate interview
Have patient sign consent form and privacy act
Conduct interview with patient & referral source
Move patient to waiting area
Post-eval conference with referral source
Give patient feedback about evaluation
Prepare medico-legal documentation
END
*Low-bandwidth teleconferencing

necessary steps for setting up the interview, none of the important checkpoints were neglected. For example, if something as simple as the lighting adjustment was overlooked before the interview, the neuropsychologist might have to spend time during the interview adjusting the lighting, which could distract the patient and detract from the interview.

When remote-site practitioners decided that a patient needed neurobehavioral consultation, they wrote a request to the neuropsychologist at NMCSD. Every request was logged into the neuropsychology service's clinic logbook.

The request was then screened by the neuropsychologist to determine whether the patient was being referred appropriately. If not, the consult was sent to the appropriate department for a second review. If the consult was appropriate, the neuropsychologist consulted with the referring healthcare provider. At this point, the neuropsychologist determined if the consultation could be accomplished using the low-bandwidth equipment. If not, a routine appointment was scheduled. (A routine appointment meant that the patient would have to travel from the remote site to the Neuropsychology Clinic at NMCSD.) If the request was considered appropriate for the use of the low-bandwidth equipment, an appointment was made for the patient

to return to the remote site for an interview with the neuropsychologist at NMCSD.

When the patient returned for the appointment, the healthcare provider or technician at the remote site explained the process of an interview using the low-bandwidth equipment and gave the patient ample opportunity to ask questions or to refuse this mode of evaluation. Before the interview with the neuropsychologist began, the technician at the remote site ensured that the patient was set up properly. In using low-bandwidth equipment, it was important that patients were instructed not to wear bright colors that would reflect a lot of light or "busy" prints that would confuse the focusing mechanism of the equipment. The interview room also had to be properly prepared to ensure the optimum setting for the interview. "Preparing" the room included ensuring that the chairs were properly positioned so that the patient was in full view of the camera. The patients were accompanied by a health care professional during the televised interview with the neuropsychologist. At the conclusion of this interview, the neuropsychologist was able to discuss the interview with the remote site practitioner.

All patients who were interviewed through the low-bandwidth equipment were tracked. If patients who were seen via the low-bandwidth equipment returned for a repeat

referral to the neuropsychologist, they would be asked to travel to NMCSD for their appointment. Their case was then reviewed to determine if the repeat referral was attributable to any limitations of the low-bandwidth equipment. No repeat referrals were seen during the study.

Data Collection and Analysis

To determine the cost effectiveness of using low-bandwidth teleconferencing equipment for neuropsychology consults, TAD/TDY cost savings were tracked for the first five months of the project. A breakeven analysis was performed using data collected from Fiscal Year (FY) 97 to predict the point at which the incurred savings from the project would pay for the equipment.

The study's validity was established through interviews with two psychologists (construct validity) and the travel department in determining TAD/TDY costs (concurrent validity).

Reliability of data accuracy involved: (a) ensuring that patient data was recorded in the logbook in a consistent and accurate fashion and (b) ensuring that TAD/TDY costs were correct by checking the figures with TAD/TDY processing experts and standard TAD/TDY reimbursement tables.

The ethical issues in this study deal with patient confidentiality. Because real patients were "tracked,"

their information was kept confidential. No names or diagnoses were collected in the data. All patients remained anonymous throughout the study.

Results of the Study

The training phase of the telepsychology project began in November 1997. The clinical utilization phase began in February 1998. In the first two months following the commencement of the clinical phase, four patients were referred for an interview using the low-bandwidth equipment.

Table 4 describes two of the patients who have already been interviewed using the low-bandwidth equipment along with the cost savings incurred by the project thus far. Also included in the table are the two patients who are scheduled to be interviewed and their potential savings.

For purposes of fine tuning the interview process using the low-bandwidth equipment, the first patient from Fort Irwin came to NMCSD for the interview. The interview was conducted with the patient in the Neuropsychology Clinic at NMCSD and the neuropsychologist in his office at another location at the Medical Center. Because the patient traveled down to San Diego from Fort Irwin, no savings were incurred. However, the interview was considered successful because the patient was appropriately recognized as a candidate for an interview through the low-bandwidth

equipment. This was the first step in showing that the low-bandwidth equipment could be used.

Table 4

Patients seen with low-bandwidth equipment and cost savings

Referral Date	Referral site	Interview date	TAD/TDY cost savings
2/18/98	Fort Irwin	3/16/98	0*
3/2/98	Fort Irwin	3/24/98	$262.00
3/24/98	29 Palms	4/15/98	$233.00**
3/25/98	Fort Irwin	To be determined	$262.00**

Note. TAD/TDY cost savings were calculated based on a roundtrip mileage reimbursement of $0.32 per mile and a per diem rate of $122.00.

*Patient traveled from Fort Irwin and was interviewed with low-bandwidth equipment at Naval Medical Center San Diego.

**Projected savings for future interviews.

Based on the success of the first patient interview, the second patient (also from Fort Irwin) was scheduled for an interview. This time, however, the patient reported to Weed Army Community Hospital on Fort Irwin (where the low-bandwidth equipment is installed) and was interviewed by the

neuropsychologist at NMCSD. The encounter was also considered successful and yielded a cost savings of $262.00.

The third interview is scheduled to take place in two weeks and the fourth interview is awaiting scheduling.

The cost of TAD/TDY per patient was calculated based on the average TAD/TDY costs of patients seen by the neuropsychology clinic during FY 97.

At what point should the savings incurred by the use of the low-bandwidth equipment pay for the equipment itself? Table 5 shows a breakeven analysis using data from FY97.

Table 5

Breakeven Analysis

$$Q = \frac{FC}{P - VC} = \frac{\$7200}{\$340 - 0} = 21 \text{ patients}$$

Note. Q = Number of patients; FC = Fixed costs; P = Price per patient; VC = Variable costs. From Essentials of Cost Accounting for Health Care Organizations (p. 85), by S. A. Finkler, 1994, Gaithersburg, MD: Aspen Publishers, Inc.

The fixed costs (FC) represents the initial equipment cost. The price per patient (P) was calculated based on the average TAD/TDY costs of patients seen by the neuropsychology clinic during FY 97. There are no variable costs (VC) associated with this project because there is no

cost incurred for each additional patient interview conducted with the low-bandwidth equipment.

In FY 97, the neuropsychology clinic saw an average of 10 out-of-town patients per month. Prior to the beginning of the study, it was determined that about half of the consultation requests received by the neuropsychology clinic were suitable for interviewing via the low-bandwidth equipment. Based on assessment of prior cases, half of the out-of-town patients, an average of five cases per month, would be suitable for assessment with the low-bandwidth equipment. The breakeven analysis projected that the breakeven point for the project should be reached in July 1998.

Based on the predicted number of patients that will be interviewed via the low-bandwidth equipment, the TAD/TDY cost savings will yield over $20,000 in the first year of the project. Not only will the use of low-bandwidth equipment yield cost savings far above the cost of the equipment, it will also decrease patient stress. Patients will not need to worry about making the trip to San Diego or finding someone to drive them. Health care providers in remote sites will also increase the amount of referrals to the neuropsychologist since the barrier of a long-distance trip is now removed.

Conclusions and Recommendations

Did the low-bandwidth equipment save enough money in TAD/TDY costs to pay for itself? As of this writing, the savings incurred by the project has not been enough to pay for the low-bandwidth equipment. However, as the project continues, the projected TAD/TDY cost savings (based on the savings thus far) will be enough to pay for the equipment by July of 1998. As such, it is cost-effective to use low-bandwidth videoteleconferencing to assess patients needing neurobehavioral psychology consultation at NMCSD, therefore the null hypothesis is rejected and the alternate hypothesis is accepted.

Many invaluable lessons were learned during the project and a few recommendations can be made for successful future telemedicine projects. One recommendation would be to ensure that all the equipment and personnel are ready before the start of the project. Due to delays in shipping, some of the remote sites did not receive their low-bandwidth equipment until after the start of the project and not all personnel were trained at the start of the project. Perhaps this contributed to the initial low number of referrals. Installation of the equipment before the start of the project would have given the personnel the opportunity to "practice" and become more comfortable with the equipment.

Another recommendation for future studies is the identification of a project champion at each of the remote sites. This project champion would be held responsible for informing fellow healthcare providers of the new available technology as it is available and would aggressively pursue patients who would be suitable for interviews using it. Although telemedicine has existed for a number of years, many practitioners have not had the opportunity to actually use telemedicine in their practice and may be hesitant in using the new technology. Therefore a colleague serving as the telemedicine champion could give encouragement to the health care provider who is hesitant.

Man hours saved as a result of the use of low-bandwidth equipment was not calculated in this study. There is no doubt that man hours are saved when this equipment is used. Patients do not need to make the arduous trips to San Diego, and minimal time is lost when patients are asked to visit the remote site clinic as opposed to driving all the way to NMCSD. In the future, studies may include the number of manpower hours saved.

In our determined efforts to increase access, decrease costs, and maintain quality, it is important to look at all avenues of improvement. However, we must also focus on using the right equipment at the right time with the right personnel at the right cost.

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